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PROF. W. PAULI

W. Pauli

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History of the Zodiac.

By B. L. van der Waerden (Zürich).

INTRODUCTION.

1. The Problem.

What nation did first discover the oblique circle, in which the sun moves, the fundamental circle of planetary astronomy? And who did first divide this zodiacal circle or "ecliptic" into the 12 well-known "signs": Aries Taurus Gemini Cancer Leo Virgo Libra Scorpius Sagittarius Capricornus Aquarius Pisces? What is the origin of the fantastical pictures of these signs on the famous Round Zodiac of Dendera (Fig. 1)? And how came these signs, originally a mathematical construction, afterwards to be worshipped like Gods and thought to influence our lives like Gods?

The last question, a part of the difficult problem of the origin of Hellenistic Astrology, cannot as yet be satisfactorily answered[1]. As to the astronomical zodiac, three civilisations have serious claims to priority: the Egyptian, the Greek and the Babylonian.

The Egyptian claim has been supported by W. Gundel[2], but his arguments are not very convincing and he himself is not quite certain; he suggests a possibility, but he is not able to prove it.

Greek sources, preserved by Plinius, ascribe the discovery of the obliqueness of the sun's circle to Anaximander, and the introduction of the zodiacal signs to Cleostratus. However, the statements concerning Cleostratus are rather obscure, and seem to be contradicted by others ascribing the "engirdlement of the zodiac" to Oenopides, while still others maintain that Oenopides stole the idea of the oblique circle from Pythagoras. The only certain facts in this confusion of opinions seem to be: Anaximander (about 550) knew that Sun and Moon move in oblique circles, and Eudoxus (about 370 B.C.) knew all about the zodiac and its twelve signs.

The Babylonian claims were most firmly supported by Fotheringham[3]. His main point is the undeniable fact that most Greek names of signs are translations or small modifications of Babylonian names. Against this argument, Webb[4] has remarked that it proves at most that most zodiacal *constellations* are of Babylonian origin, but not the exact notion of a zodiacal *sign*, and the description of the sun's path as an oblique circle. The constellations in the moon's path have been enumerated and named at an early date, but the determination of the sun's path between the stars is a more difficult matter, a matter of exact measurement and reasoning, and the mere observation and listing of zodiacal constellations does not necessarily lead to a division of the sun's circle into 12 signs.

Thus, two concepts should be clearly distinguished:

1) the *zodiacal belt*: a belt of some 12^0 breadth in which the planets (including Sun and Moon) move, with its *constellations*, the number of which need not be restricted to 12,

2) the *ecliptic:* a line in the middle of the zodiacal belt, the sun's orbit and locus of moon eclipses, divided into 12 *zodiacal signs* of 30 degrees each.

As we shall see, the zodiacal belt was known in Babylonia as early as 700 B.C. The text ^{mul}APIN lists some 15 constellations in it and says that the moon, the sun and the other planets follow this path. The text VAT 4956 records distances of planets from zodiacal stars in "cubits", for the year 568/7 B.C.

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[1]) We refer the reader to the standard work of Bouché-Leclercq, *L'Astrologie grecque*, to a summary of more recent investigations by O. Neugebauer, *J. Near Eastern Studies* 4, p. 1, and to Festugière, *La Révélation d'Hermès Trismégiste* I (1944), II (1949).

[2]) W. Gundel, *Dekane und Dekansternbilder*, Hamburg 1936, p. 327; *Neue Texte des Hermes Trismegistos, Abh. Bayer. Akad. Wiss.* (Phil.-hist.), N. F. 12 (1936), Kap. 5.

[3]) J. K. Fotheringham, *Cleostratus, J. Hellenic Studies* 39 (1919), p. 164 and 45 (1925), p. 78.

[4]) E. J. Webb, *J. Hellenic Studies* 41 (1921), p. 70, and 48 (1928), p. 54.

However, in a text from the year 419 B.C. a new system appears: now positions of planets are recorded by indicating in which signs the planets are. In Seleucid lunar and planetary tables, the system is even more refined: positions are calculated arithmetically and expressed in terms of signs, degrees and their sexagesimal parts. The signs are of exactly equal length: 30 degrees each. Observational tablets and calculated ephemerides of the 2nd century B.C. record the dates of entrance of planets into signs. Full references to texts will be given in Chapter I.

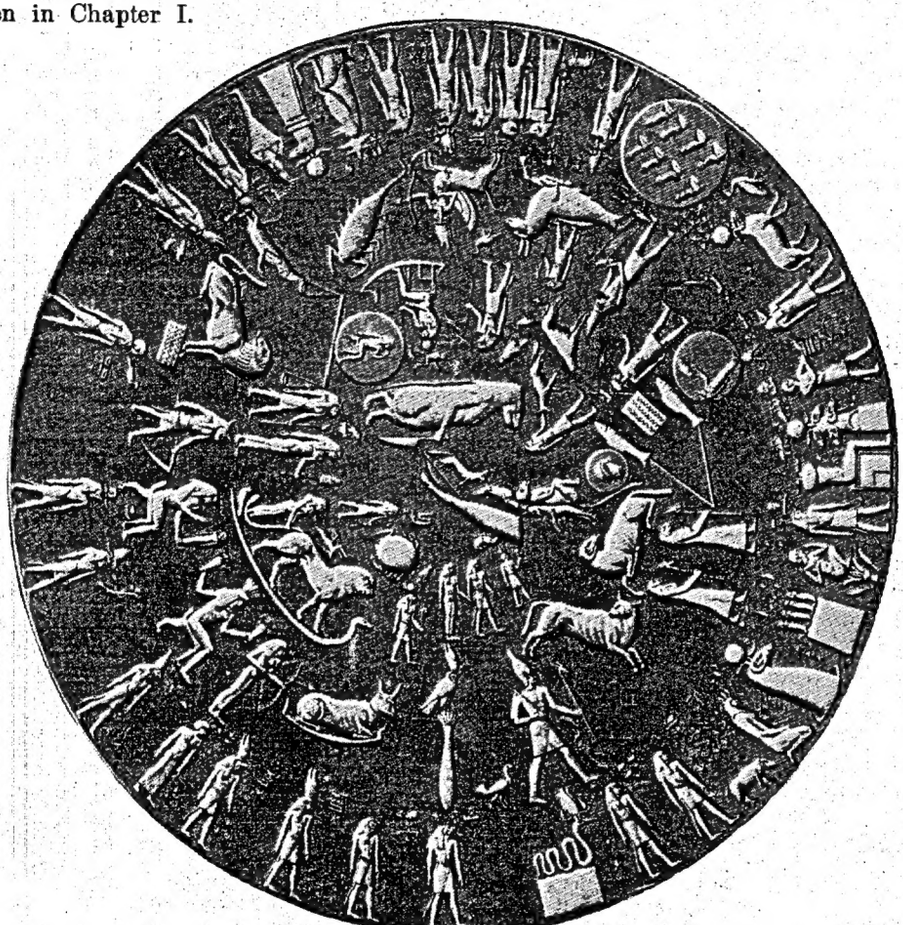

Fig. 1. Round Zodiac of Dendera. From the *Déscription de l'Égypte*, Vol. IV, Pl. 21.

What is the explanation of this change of system? Did the Babylonians learn these mathematical notions from Greek scientists such as Hecataeus, who visited Babylonia in the first half of the 5th century?

This is extremely improbable. Babylonian observational astronomy had nothing to learn from the Greeks: it was far ahead of them. The Babylonians had observed and recorded planetary positions for centuries, the Greeks had not. The reason for the use of signs instead of stars in Babylonian planetary records cannot be that the Greeks had just discovered the notion of a zodiacal sign; it must be that the Chaldaeans themselves considered, for some astronomical or astrological reason, the zodiacal signs as something very important, which implies that they had developed this notion long before.

The conclusive proof of the Babylonian origin of the 12 signs can be given by penetrating into the motives, why they were introduced and considered as important. We ask: For what purpose did Greeks and Babylonians use the signs? Why did they want to

have exactly 12 signs instead of any number of constellations scattered over the zodiac? Why are the signs (the Greek as well as the Babylonian ones) of equal length? Why were they divided into 30 degrees each?

2. The practical use of the signs.

One purpose for which the Greeks used the signs is explained in the famous poem of Aratos, the *Phainomena*[5]. It is the determination of time during the night. At sunset 6 signs stand above the horizon, for the zodiac is halved by the horizon. The point opposite to the sun rises at sunset, and the sun itself rises at the end of the night, which means that exactly 6 signs rise during the night. The time, in which any one of these signs rises, is approximately one sixth of the night, i. e. approximately 2 "night hours". Thus, observation of the rising signs is a means of determining the number of hours elapsed since sunset. Aratos then gives a number of stars rising simultaneously with the signs of the zodiac, which may be used if the exact limits of the signs are not known or if a cloud or mountain hinders their observation.

In a recent paper[6], I have shown that this method of determining time originated in Babylonia, and that it is connected with the division of night and day into 12 seasonal hours each, which is Babylonian as well.

Still more important is the use of *zodiacal schemes* in Greek calendars. A zodiacal scheme is a division of the year into 12 artificial months[7], during which the sun dwells in the 12 zodiacal signs. It will be shown that such a zodiacal scheme is already implied in the text ^{mul}APIN, and that *the notion of a zodiacal sign arose with necessity from this zodiacal scheme.*

This answers all our questions. There are 12 signs, because there are 12 months in the schematical year of ^{mul}APIN[8]. The signs were made of equal length in order to get months of equal duration; they were divided into 30 degrees each because the schematical months were supposed to contain 30 days each.

In this way the Babylonian origin of the geometrical notion "zodiacal sign" will be established beyond any doubt, and the motives for its invention will be made clear.

3. The Greek and the Egyptian Zodiac.

We shall see how the Greeks modified the Babylonian Zodiac and replaced one of the names, that of the first sign, by a new one (Aries) of unknown (perhaps Egyptian) origin. We shall further show that the astrological zodiac of Hellenistic times is a mixture of the original Babylonian Zodiac with the Greek modified zodiac[9], and that the pictures of the Zodiacs of Dendera in Egypt (First century A. D.) are closely related to Babylonian representations on seals and boundary stones. We shall further discuss the origin of the 36 Hellenistic "Decans" represented on the Round Zodiac of Dendera.

Generally speaking, Hellenistic astrology proves to be a mixture of mostly Babylonian, some Greek and a few genuine Egyptian elements.

CHAPTER I.

THE BABYLONIAN ZODIAC.

1. Zodiacal Constellations.

The zodiacal belt with its constellations was known in Babylonia as early as 700 B. C. The first tablet of the series ^{mul}APIN[10] lists "the constellations in the path of the moon" as follows[11]:

5) According to Hipparchos, the poem is mainly a poetic version of the *Phainomena* of Eudoxus. now lost.

6) B. L. v. d. Waerden, *Babylonian Astronomy* III, *Journal Near Eastern Studies* 10 (1951), p. 20.

7) Artificial, because the civil months were, in Greece as well as in Babylonia, determined by the moon and not by the sun.

^{mul}mul (= *zappu*, the hair bush) = Pleiades
^{mul}gu$_4$.an.na (the bull of Anu) = Taurus
^{mul}sib.zi. an.na (Anu's true shepherd) = Orion
^{mul}šu.gi (= *šību*, the old man) = Perseus
^{mul}gàm (= *gamlu*, sicle sword) = Auriga
^{mul}maš.tab.ba.gal.gal (the great twins) = Gemini
^{mul}AL.LUL = Prokyon or Cancer [12]
^{mul}UR.GU.LA (lion or lioness) = Leo
^{mul}ab.sin (furrow) = Spica
^{mul}*zi-ba-ni-tum* (the scales) = Libra
^{mul}gír.tab (scorpion) = Scorpio
^{mul}PA.BIL.SAG (archer?) = Sagittarius
^{mul}suḫur.máš (goatfish) = Capricornus
^{mul}GU.LA (great star or giant?) = Aquarius
^{mul}*zibbâti*^{meš} (the tails) = Pisces
^{mul}šim.maḫ (the great swallow) = Piscis SW + ε Pegasi
^{mul}*a-nu-ni-tum* (the Goddess Anunitum) = Piscis NE + middle part of Andromeda
^{mul}lúḫun.ga (= *agru*, the hireling) = Aries

For the identification of the constellations, see F. X. Kugler, *Sternkunde u. Sterndienst*, Erg. 2, p. 207; P. Gössmann, *Planetarium Babylonicum*, Vol. IV, 2 of Deimel's *Šumerisches Lexikon* (Rome 1950).

The text states explicitely that not only the Moon, but also the Sun and the other planets move in the "moon's path" defined by these constellations.

As a matter of fact, all constellations mentioned belong to the zodiacal belt, with the exception of Orion, Perseus and Auriga. Why were these three added to the list? Modifying a suggestion by Dr. R. Böker, I suppose they were added as "paranatellonta", simultaneously rising stars, to the signs Aries and Taurus. In astrological literature, Perseus is mentioned as rising with Aries, and so are Auriga and Orion with Taurus. See F. Boll, *Sphaera* p. 41—43, and W. Gundel, *Neue Texte des Hermes Trismegistos*, p. 51—54.

Later texts tend either to multiply or to reduce the number of stars and constellations. In order to be able to define the positions of planets in the zodiacal belt quite exactly, new star groups were named (e. g. Praesepe) and names were given to single zodiacal stars. A list of 33 such stars, taken from Babylonian ephemerides, was given by Kugler, *Sternkunde u. Sterndienst* II, p. 550. On the other hand, in Babylonian lists of zodiacal constellations their number is gradually reduced to 12. In the so-called TE-tablet, written about 400 B.C.[13] šu.gi and gam are missing, šim.maḫ and *anunītum* are replaced by *ikū* (= Pegasus), and their tails *zibbāti* are called *rikis nūni:* the Band of the Fishes. In a late-Babylonian text published by Thureau-Dangin, *Tablettes d'Uruk* 14, we are left with the well-known 12 constellations or zodiacal signs:

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[8]) The civil year consisted of 12 or 13 months, but the scheme simplified it.

[9]) This has already been pointed out by A. Schott, *Quellen und Studien Gesch. Math.* B 4, p. 176.

[10]) See E. Weidner, *Amer. J. Sem. Lang.* 40, p. 186, and *Archiv f. Orientf.* 7, p. 170. An Assyrian copy of ^{mul}APIN bears the date 687 B.C., but the observations upon which the text is based were certainly made in Babylonia, most probably between 1400 and 900 B.C. See my *Bab. Astron.* II, *J. Near Eastern Studies* 8, p. 6.

[11]) Spaced upright types mean Sumerian words or ideograms such as mul = star. Italics mean Accadian words. Capitals will be used whenever I do not know how the cuneiform sign should be read in the case under consideration.

[12]) In the list of *Ziqpu*-stars published by Schaumberger (*Z. f. Assyriol.* 50, p. 228) ^{mul}AL.LUL can only mean the central part of Cancer (Praesepe). In other texts AL.LUL stands for the sign Cancer. However from the list of heliacally rising stars in ^{mul}APIN it is quite clear that AL.LUL must include Prokyon. Most probably AL.LUL is Prokyon + Cancer.

[13]) See Weidner, *Handbuch*, p. 121. Photograph in E. A. W. Budge, *The Babylonian Legends of the Creation*, London 1921, p. 24.

^{lú}ḫun.ga	= Aries	*zi-ba-ni-tu*	= Libra
mul	= Pleiades	ĝír.tab	= Scorpio
maš	= Gemini	PA	= Sagittarius
KUŠÚ [14]	= Praesepe	suḫur	= Capricornus
ur.a	= Leo	GU	= Aquarius
ab.sín	= Spica	*zib*	= Pisces

The identification of the constellations is quite certain from observational texts of the Seleucid age. That KUŠÚ means Praesepe is proved by the observational text VAT 4956, transcribed and discussed by P. V. Neugebauer and E. Weidner, *Ber. Sächs. Akad.* 67 (Leipzig 1915). An autograph of this text, made by E. Weidner, will be reproduced as Plate XVII. The text records positions of planets with respect to zodiacal signs for the year 568/7 B. C. In this text, KUŠÚ clearly means Praesepe and nothing else. However, in the *ziqpu*-star list VAT 16436, KUŠÚ is said to contain 10 stars. In another *ziqpu*-star list, AL.LUL takes the place of KUŠÚ. Both lists have been published by J. Schaumberger, *Z. f. Assyriol.* 50, p. 222.

2. The 12 zodiacal signs.

They occur for the first time in the planetary text VAT 4924 for the year 419 B. C. mentioned before. By Dr. Weidner's kindness, an autograph of this text will be reproduced as Plate XVIII. The text contains statements of the following kind:

(Obv. 5) *Nisannu:* Jupiter and Venus at the beginning of Gemini, Mars in Leo, Saturn in Pisces. 29th day: Mercury's evening setting in Taurus.

(Rev. 13) *Addaru II:* Jupiter at the beginning of Cancer, Venus in Aries; Saturn, Mars and Mercury invisible [15].

Schnabel, Weidner and Rehm, who discussed this text, all agree that the positions refer to signs, not to zodiacal configurations. Still, the names of signs used in this and other similar texts were taken from constellations they contain. Thus, the sign Taurus may be denoted by mul (Pleiades), by gu$_4$.an.na (Taurus) or by *is li-e* [16] (Hyades + Aldebaran); similarly the sign pisces is denoted by *zib* ^{meš} (tails of the Fishes) or by *ikū* (Pegasus), and the sign cancer by AL.LUL (Prokyon + Cancer?) or KUŠÚ (Praesepe). Whether sign or constellation is meant, should in each case be concluded from the context. If e. g. in a lunar tablet the position of the Full Moon is given as 17° 24′ maš, it is clear that maš means the sign Gemini, not the constellation.

The Babylonian signs are of *strictly equal lengths.* This is quite clear from a table on p. 519 of Kugler's *Sternkunde* II, where Kugler has calculated the coordinates of the limiting points of Babylonian signs from almanacs and observational texts of the period 200—70 B. C. The lunar and planetary tables, in which each sign contains 30 degrees, confirm the conclusion that the signs had equal lengths.

In the light of such facts no credit whatever can be given to the talk of Sextus Empiricus, who asserts that the Chaldaeans defined the zodiacal signs so as to rise in equal times, measured by water clocks (*Adv. Math.* V 23).

In the lunar tables, magnitudes of solar eclipses are calculated from the latitudes of the new moon. This shows that their authors knew: first of all, that solar eclipses are caused by the new moon covering the sun, secondly that the sun has no motion in latitude, but moves exactly in a circle: the "ecliptic" or "middle line of the zodiac", as it is called in Greek.

On the whole, Babylonian lunar tables were computed by purely Babylonian methods and show no sign of Greek influence. This is clear for anyone familiar with Greek astronomy and with Kugler's *Babylonische Mondrechnung.*

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[14]) The ideogram KUŠÚ = NANGAR = SAL + DIŠ + U was formerly read as *nangaru* or *pulukku.* The reading kušú was proposed by Ungnad, this *Archiv* 14, p. 256. See, however, Gössmann, *Planetarium Babylonicum* 114, No. 294. According to A. Sachs, *J. Cuneif. Stud.* 6 (1952), p. 54, the correct reading would be alla or the like, not kušú or nangar.

[15]) A. Rehm, *Parapegma-Studien, Abh. Bayer. Akad. Wiss.* (Phil.-Hist. Kl.), N. F. 19 (1941), p. 23.

[16]) *is li-e* = bull's jaw. See J. Schaumberger, 3rd *Ergänzungsheft* to Kugler's *Sternkunde*, p. 336.

3. The Zodiacal Scheme.

A division of the year into 4 astronomical seasons, each corresponding to 4 parts of the zodiacal circle, is implied in the following statements of the text ^{mul}APIN[17]:

> From XII 1 until II 30 the Sun is in the path of the (stars) of Anu: Storm and Wind.
> From III 1 until V 30 the Sun is in the path of those of Enlil: Harvest and Heat.
> From VI 1 until VIII 30 the Sun is in the path of those of Anu: Storm and Wind.
> From IX 1 until XI 30 the Sun is in the path of those of Ea: Cold.

Here the "path" of the stars of Anu is a belt from nearly 17° North to 17° South of the equator[18], whereas the "paths" of the stars of Enlil and Ea are the regions North and South of these limits. The Roman numerals stand for the names of Babylonian months.

These statements show that already at this early date (about 700 B. C.) the sun's orbit was conceived as a line intersecting the limiting circles of the zones of Enlil, Anu and Ea in 4 points and divided by them into 4 segments, such that the sun dwells 3 months in each segment.

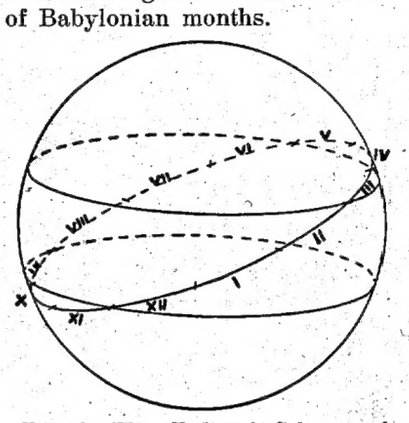

Fig. 2. The Zodiacal Scheme of ^{mul}APIN. From *Journ. Near Eastern Studies* VIII, p. 24.

It is true that this zodiacal scheme is incomplete: the year is divided into 12 artificial months, whereas the zodiacal circle is divided into 4 segments only. Still, the division of the year into 4 astronomical seasons corresponding to these segments was already a zodiacal scheme; and as each season consisted of 3 months, the system itself called for a division of each zodiacal segment into 3 "signs", as indicated in fig. 2, in order to make the correspondence complete. This last step was perhaps taken soon afterwards, in any case before 419 B. C.

The idea of some correspondence of months to constellations is very old: it goes back to the so-called Astrolabe lists (1100 B. C. or earlier), which assign to every month 3 stars or constellations supposed to rise in that month[19]. However, in this old system the correspondence was bad: many constellations did not rise in the months assigned to them. The correspondence of zodiacal constellations to months was much better, for nearly each 12th part of the zodiac contained at least one constellation; and it was made quite perfect by the introduction of the notion "zodiacal sign".

4. The first sign: Aries or Taurus?

If our opinion that the signs were meant to correspond to the months is right, the first sign should correspond to the first month. Now according to the zodiacal scheme of ^{mul}APIN the sun dwells during the month Nisannu in the sign ḫun.ga (Aries). This explains why all younger texts begin the list of signs with ḫun.ga.

However, the older lists of zodiacal configurations (not yet signs) begin with mul. How can this be explained? Very simply: the old Astrolabe lists assigned the configuration mul to the first month Nisannu, and also in ^{mul}APIN it was supposed to rise on Nisannu 20. Since in these old texts the configurations were mainly connected with the months in which they rose, it was quite reasonable to begin the list of zodiacal configurations with mul (Pleiades).

Of course, both conventions are highly arbitrary. The beginning of the civil year depended on the visibility of the moon's crescent and on arbitrary intercalation, so the actual rising of Pleiades could fall into the second month just as well as into the first, and the sun could be in Pisces, Aries or Taurus during the first month. Thus, the correspondence of the signs to months is largely a question of convention. Precession worked, though very slowly, in

[17]) See E. Weidner, *Archiv f. Orientforschung* 7, p. 170.
[18]) See J. Schaumberger, 3rd *Ergänzungsheft* to Kugler's *Sternkunde und Sterndienst*, p. 321.
[19]) B. L. v. d. Waerden, *Babylonian Astronomy* II, *J. Near Eastern Studies* 8 (1949), p. 9.

favour of Aries against Taurus, for every 200 years Aries would rise 3 days later in the solar year.

5. Limiting Points of Signs.

Since Hipparchus, we are wont to identify the beginning point of the sign Aries with the spring equinox. However, we must not stick to this. *In Babylonian and early Greek astronomy the beginning points of the signs are rigidly connected, not with the equinoxes, but with the fixed stars.* For Babylonian astronomy, this was first proved by Kugler from Lunar Tables, and planetary tables confirmed it. As for Greek astronomy, see Chapter II.

The reasons for connecting the signs with the stars are quite obvious. First, the stars are easily observable, whereas the equinoxes are not. Secondly, the equinoxes have nothing to do with the purpose for which the zodiacal signs were introduced. The zodiacal signs had to meet two requirements: First they had to coincide approximately with the constellations from which they took their names, secondly they had to correspond approximately to the months of the civil year. The first requirement is much more concise, for the stars are always at the same place, whereas the beginning of the civil year changes with the moon from year to year. As a matter of fact, the limiting points of the signs are defined within a few degrees by the conditions that (I) the signs should be of equal length, and (II) the zodiacal constellation should fall as well as possible within their signs[20]. A small shift backward — and Spica would not fall within the sign Virgo, which would seem absurd to any Babylonian astronomer.

Following Kugler, we shall define the position of the origin of the Babylonian zodiac by comparing it to the equinox of the year — 100. Let the longitude of any star or planet, calculated with respect to the equinox of the year — 100 (i. e. with the vernal point of — 100 as origin of coordinates) be called *Kugler longitude*, and let the longitude as given in Babylonian planetary tables be called *Babylonian longitude*. The mean difference of the two longitudes (Babylonian minus Kugler) measures the distance between the Babylonian origin and the vernal point of — 100. Now from several lunar and planetary tables Kugler and myself have computed the following mean differences:

Tables	Years	Difference
Lunar table Nr. 93, System II[21]	— 174 to — 154	3.7
Lunar table Nr. 272, System I[22]	— 103 to — 101	3.3
Jupiter tables, 1st kind[23]	— 180 to — 90	4.2
Jupiter tables, 2nd kind[23]	— 120 to — 100	4.2
Jupiter tables, 3rd kind[24]	— 120 to — 80	4.3
Babylonian Almanacs[25]	— 210 to — 160	3.5
	— 160 to — 130	4.2
	— 110 to — 60	5.3

These values range from 3.3 to 5.3, which means that the vernal point of — 100 lies near 4.3° Aries of the Babylonian zodiac, and Spica near 29° Virgo, with a possible deviation of 1° to either side.

[20]) See the computations of R. Böker, *Entstehung der Sternsphäre Arats*, *Ber. Sächs. Akad.* 99 (Leipzig 1952), p. 43. [21]) F. X. Kugler, *Babylonische Mondrechnung*, p. 58.

[22]) F. X. Kugler, *Babylonische Mondrechnung*, p. 102.

[23]) B. L. v. d. Waerden, *Eudemus* I (1941), p. 33. [24]) F. X. Kugler, *Sternkunde* I, p. 158.

[25]) These texts, formerly called ephemerides, give the days of entrance of Jupiter, Saturn and Venus into signs of the zodiac. As I wrote my *Eudemus* paper, I believed at least one of these texts to be an observational record, I computed a standard error from it, and I concluded that in the later texts (110 to 60 B. C.) a shift of the origin of the zodiac had taken place. I now believe with A. Sachs that all entrances of planets into zodiacal signs were computed, and that the deviation of the later almanacs from the earlier ones is due to a systematic error of about 1° in the Venus positions. See A. Sachs, *J. of Cuneiform Studies* 2 (1948), p. 277 and 289.

This result, obtained several years ago, is strikingly confirmed by a Babylonian star catalogue, recently published by A. Sachs [26]. Restricting ourselves to 5 entries that can be identified with certainty, we find in this list the following longitudes. I have added to the list two Jupiter longitudes, drawn from planetary tables and probably observed in the years 108 and 158 SE [27].

Text	Star name	Bab. Long.	Kugler Long.	Difference
BM 46083	β Virginis	151	147.6	3.4
	γ Virginis	166	161.2	4.8
	α Virginis	178	174.7	3.3
	α Librae	200	195.9	4.1
	β Librae	205	200.2	4.8
AO 6476	Jupiter 108 IX 4	151.75	148.05	3.7
Sp. II 889	Jupiter 158 XII 10	230.17	226.20	4.0

The mean difference is 4.1, the standard error of the single observations 0.6.

6. Equinoxes and Solstices; Precession.

In Greek geometrical astronomy, the equinoxes and solstices are of prime importance: they determine the points of intersection of the fundamental circles on the sphere, which were needed for all calculations and constructions. This is why the Greeks made, ever since Meton and Euctemon (420 B. C.), exact observations of equinoxes and solstices, which enabled Hipparchus (150 B. C.) to discover precession.

In Babylonian astronomy, the situation is quite different. Equinoxes and solstices play only a minor part, in the theoretical as well as in observational texts. Longitudes and latitudes of sun, moon and planets were calculated arithmetically, but the calculated positions were not related to the equator, and hence the points of intersection of equator and ecliptic were quite unimportant.

The only point where equinoxes and solstices come in is the calculation of the duration of night and day. Now, an error of some 2 or 3 days in the observation of equinoxes would mean an error of 8 minutes at most in the duration of daylight, i. e. of 4 minutes in the moment of sunset, which is quite unimportant. So why should the Babylonians bother about an exact determination of equinoxes? They simply fixed them at 10^0 of the signs in the older System II of their Lunar Theory, and at 8^0 in the younger System I. These fixations were retained during several centuries, disregarding precession. The right thing would have been to fix them for 200 B. C. at 5^0, and to correct them afterwards by repeated observations.

In Babylonian planetary calendars, the lengths of the astronomical seasons were assumed to be equal, although the scribes might have concluded the inegality of the seasons from their own Lunar Tables. This proves, again, how little attention was given to such things. The spring equinoxes have errors up to 5 days [28]. In observational tables, the equinoxes and solstices are noted, but time and again there is a remark: "not observed" (Kugler II, p. 521). Obviously the dates were calculated from year to year by some simple scheme, such as Neugebauer has recently published [29].

Conclusion: The Babylonians did not discover precession, because they did not care for exact observation of equinoxes and solstices. They were content with rough estimates, and they were quite right in that from their point of view.

In the zodiacal scheme of ^{mul}APIN, the equinoxes and solstices were fixed at 15^0 of the signs. This is clear from a glance at fig. 2, and it is confirmed by the text itself, which states that on Nisan 15 day and night are equal. Fig. 2 would be correct, with the Babylonian

[26] A. Sachs, *A late Babylonian star catalog, J. Cuneiform Stud.* 6 (1952), p. 146.
[27] B. L. v. d. Waerden, *Eudemus* I, p. 45—46.
[28] See Kugler, *Sternkunde und Sterndienst in Babel* II, p. 606.
[29] O. Neugebauer, *A table of solstices from Uruk, J. Cuneiform Studies* 1 (1947), p. 143.

limits of signs, for about 940 B. C. Other statements in the same text, concerning heliacal rising of stars, point to a somewhat earlier date, say between 1400 and 900 B. C.

7. Worship of Zodiacal Signs. Birth horoscopes.

A much-discussed text of Diodorus indicates that 12 stars in the zodiac and 12 stars north and 12 south of it were considered by the Chaldaeans as Gods, having the supervision over all things in heaven and on earth. We know from cuneiform texts too that stars were worshipped as Gods. For the zodiacal signs or constellations we have 3 magical texts, published by Ungnad[30], prescribing to repeat the names of the signs a certain number of times in different cases. This proves that zodiacal signs (or constellations) were considered as mighty powers.

The same idea underlies horoscopic astrology. Bouché-Leclercq has made quite clear that all pseudo-physical arguments by which astrologers try to make plausible the influence of planets and zodiacal signs upon our lives, are only disguises, the primary idea being that the planets and signs are Divine Powers. Now this is clearly a Babylonian idea. The accomplished system of astrology with its vague religious background could be transplanted into any other land, but it could originate only in a country where the stars, planets and zodiacal signs were worshipped as gods, i. e. in Babylonia.

The text VAT 4924 mentioned before, recording the zodiacal signs in which the planets are in the year 419/8 B. C., may have been used as an auxiliary table in casting horoscopes. I can scarcely imagine any other purpose for such a table. The obvious conclusion is, that already in the Persian time the Babylonians cast horoscopes.

This conclusion has been confirmed quite recently by a horoscope for 410 B. C. published by A. Sachs[31]. In the same paper Sachs published 5 more horoscopes for the years 263, 258, 235, 230 and 142 B. C. All of these are older than the oldest known Egyptian horoscope. So the conclusion seems unavoidable that *horoscopic astronomy originated in Babylonia during the Persian reign.*

Dr. Sachs arrives at the same conclusion. He writes: "If I am right — and I do not see wherein I might have erred — in restoring the date of the earliest cuneiform horoscope as 410 B. C., there actually remains next to no chance that extra-Babylonian influences played a role in the earliest development of horoscopic astrology."

Older Babylonian astrology, which flourished in Kassite and Assyrian times (1400—700 B. C.) had a quite different character: it aimed at *short-range predictions* of *general public events*, such as wars and harvests, from *striking phenomena* such as eclipses, clouds, annual rising and setting of planets, whereas the Hellenistic "Chaldaeans" predicted *individual fates* from *positions of planets and zodiacal signs* at the date of *birth or conception.*

It is true that personal predictions are found already in earlier times, as Sachs has pointed out. It is also true that Hellenistic astrologers continued to predict public events. So the individual character of horoscopic astrology should not be stressed too much. The essential new feature is, that *positions of planets* and *zodiacal signs* are used for long-range predictions.

Now these positions are by no means striking events: planets may be invisible, and signs are never visible. The data needed for a horoscope had, in most cases, to be calculated from tables. We ignore how, when and why this transformation took place. But it could only take place in Babylonia, where tables were available for calculating positions of planets at remote dates. Not without reason astrologers were called "Chaldaeans" throughout the Roman Empire!

CHAPTER II.

THE GREEK ZODIAC.

1. General Notions.

We have seen, how the notions concerning the zodiacal belt, the ecliptical signs and the zodiacal scheme gradually developed in Babylonia. From about 1000 B. C. onwards, more

30) A. Ungnad, *Archiv f. Orientforschung* 14, p. 251.

31) A. Sachs, *Babylonian horoscopes, J. Cuneiform Studies* 6 (1952), p. 49.

and more attention was given to the zodiacal belt, in which the moon, planets and the sun move. Before 420 B. C. the system of the 12 zodiacal signs was established with complete clarity and precision. We found the fundamental idea of the zodiacal scheme already in the text ^{mul}APIN, written about 700 B. C. or earlier. We were able to reconstruct the leading ideas and to understand their gradual development without assuming any foreign influence at all.

In Greece and Egypt, the situation is quite different. The Greeks did not study the motion of the planets during many centuries. Democritus is said to have been quite uncertain about the number of planets and to have considered their motion as totally irregular. In Plato's time, when Eudoxus set up his brilliant planetary theory, its observational basis and the knowledge of periods etc. was still quite insufficient. For instance, Eudoxus ignored the sun's anomalistic motion in longitude, but he believed in a motion in latitude which does not exist [32].

The Greek zodiac with its 12 signs was not, like the Babylonian zodiac, the result of a gradual development, starting with long and careful observations of planets and zodiacal constellations, but it apparently was introduced all at once by Cleostratus, after Anaximander had discovered its obliquity:

Obliquitatem eius intellexisse, hoc est rerum foris aperuisse, Anaximander Milesius traditur primus olympiade quinquagesima octava (548—545 B. C.), *signa deinde in eo Cleostratus, et prima arietis ac sagittarii* (Plinius, *Nat. Hist.* II, 31).

The exact meaning of this phrase is not quite clear: Fotheringham and Webb had a long discussion about it in Vol. 39, 41, 45 and 48 of the *Journal of Hellenic Studies*. Equally obscure is a statement about Oinopides, quoted from Dercyllides by Theon of Smyrna: "Eudemus tells us in his History of Astronomy, that Oinopides first discovered the engirdlement of the zodiac." We do not know, what the word engirdlement (*διάζωσις*) exactly means. Diels proposes to read skewness (*λόξωσις*).

The light of history begins to shine only about 400 B. C. Zodiacal schemes were then used by Euctemon and Eudoxus in their calendars [33], and a division of the ecliptic into 12 strictly equal signs was used by Eudoxus in his *Phainomena*, the source of Aratus' famous poem.

Eudoxus' and Aratus' statements concerning the stars rising simultaneously with zodiacal signs were thoroughly analyzed by Dr. Böker [34]. His main results are:

1. Just as the Babylonians did, Eudoxus used a fixed zodiac with 12 signs of equal length, rigidly connected with the fixed stars. The equinox of — 100 lies between 2° and 3° Aries on the ecliptic of Eudoxus. His division differs only 1 or 2 degrees from the Babylonian division. The zero point of Ptolemy's catalogue of stars happens to coincide with the zero point of Eudoxus.

2. Eudoxus assumes, just as ^{mul}APIN does, the equinoxes and solstices to lie at 15° of the signs. This would be true for 1000 B. C., but not for his own time (370 B. C.).

3. Eudoxus had adjusted his globe to a geographical latitude of 33°, corresponding to Babylonia or Phoenicia.

To these facts, we may add that most names of Greek zodiacal signs are translations or small modifications of the Babylonian names, as will be seen presently. Hence the conclusion is unavoidable that *the whole Greek zodiac with its 12 signs is of Babylonian origin.*

2. Names of Signs.

The Greek names of the signs Taurus, Gemini, Leo, Scorpius, clearly are translations of the Babylonian names gu$_4$.an.na, maš.tab.ba.gal.gal, ur.a, gír.tab, which mean 'bull of Anu', 'the great twins', 'lion' or 'lioness', 'scorpion'.

[32]) See the classical memoir of Schiaparelli, *Le sfere di Eudosso* etc.; German translation in *Abh. Gesch. Math.* 1.

[33]) See A. Rehm, Art. *Parapegma* in *Pauly's Real-Enzykl.*, and *Parapegma-Studien, Abh. Bayer. Akad.*, N. F. 19.

[34]) R. Böker, *Die Entstehung der Sternsphäre Arats, Ber. Sächs. Akad. Wiss.* 99 (Leipzig 1952).

Capricornus (*Αιγόκερως*) is just a slight modification of the goatfish (s u ḫ u r - m á š).

The Babylonian name of the sign Virgo and of the star Spica, a b s i n or a b . s í n, originally means 'furrow'. However, the text ^{mul}APIN states: "^{mul}a b s i n ist the corn ear of the goddess Šala" (*Cuneif. Texts* 33, BM 86378, Col. II 10). The Seleucid text AO 6448 (see fig. 3) shows a virgin holding an ear representing ^{mul} a b . s í n. I do not see any reason to

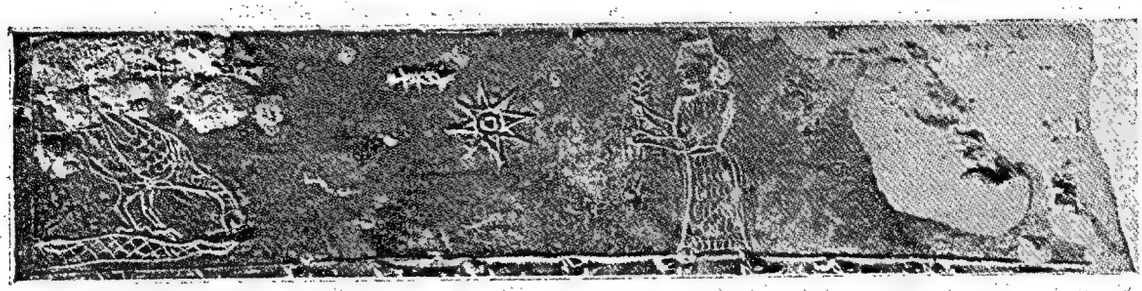

Fig. 3. Virgin with corn ear, representing a b . s í n. From *Archiv f. Orientforschung* IV, pl. III.

ascribe this picture to Greek influence, because in all other cases the influence is the other way round; but even if it is not admitted for certain that the Greek name of the sign Virgo came from Babylonia, it is in any case certain that the corn ear (Spica) is of Babylonian origin.

Instead of the Babylonian scales (*zibānītu*) the Greeks have the scorpion's claws (*χηλαί*). But the text ^{mul}APIN already gives *qaran zuqāqīpi* (the scorpion's horn) as a synonym of *zibānītu* (*Cuneiform Texts* 33, BM 86378, Col. II 11).

The Greeks reduced the Babylonian constellations š i m . m a ḫ and *anunītum* to our much smaller fishes, most probably because the head of š i m . m a ḫ was already a part of the Greek configuration Pegasus, and the head of *anunītum* was the middle part of Andromeda [35]. Still, the combination of the tails of š i m . m a ḫ and *anunītum* to one zodiacal constellation called "the tails" (*zibbāti*^{meš}) was already performed in the text ^{mul}APIN, and the part of the constellation near α piscium was called by the Babylonians just as by the Greeks "the band of the fishes" (*rikis nūni*).

Sagittarius is represented on the round zodiac of Dendera by a centaur with wings and a bow, similar in all details to a picture on Babylonian boundary stones (figs. 4 and 5). We can leave open the question whether the symbol on the boundary stones already meant a constellation or whether it represented a minor god, afterwards transferred to the sky. In the analogous case of the goatfish, represented in Dendera and on the boundary stones by quite similar pictures (figs. 6 and 7), we know that it was transferred to the sky before 700 B. C., since the constellation s u ḫ u r - m á š is mentioned in ^{mul}APIN. Probably the same is true in the case of sagittarius. Thus, although we ignore the exact signification of the name PA . BIL . SAG, we may safely conclude from the pictures that the archer is of Babylonian origin. The Greeks preferred the picture of a silen with a bow.

Also in the case of Aquarius we ignore the exact signification of the Babylonian name GU . LA, but we have old Babylonian representations of a water-pouring god analogous to the waterman of Dendera (figs. 8 and 9).

The case of Cancer is doubtful, because we ignore the meaning of the ideogram AL . LUL = a l . l u$_5$ used in older texts, and of the ideogram KUŠŪ = NANGAR used in later texts to design the sign Cancer. The Accadian equivalent of AL . LUL is *šittum*. According to Landsberger, *alluttu* is a crab, but ^{mul}*Alluttu* is Capricornus, not Cancer. A *kušū* appears in a list of animals. This seems to be all we know. See B. Landsberger, *Die babylonische Fauna* (Leipzig 1934), p. 18; A. Ungnad, this *Archiv* 14, p. 256; F. Thureau-Dangin, *Rev. d'Assyriol.* 10, p. 225; Gössmann, *Planetarium Babyl.*, p. 5; A. Sachs, *J. Cuneif. Stud.* 6, p. 54.

The Babylonian "hireling" (ḫ u n . g a = *agru*) was replaced, in the Greek zodiac, by a Ram, of unknown origin.

[35]) See B. L. v. d. Waerden, *The 36 stars, J. Near Eastern Studies* 8 (1949), p. 15, Fig. 3.

Fig. 4. Archer on Boundary Stone. From Hinke, *New Boundary Stone*, p. 98, Fig. 32.

Fig. 5. Archer on Round Zodiac of Dendera. From Hinke, p. 99, Fig. 33.

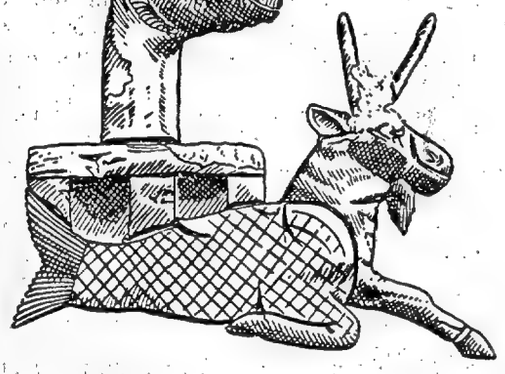

Fig. 6. Goatfish on Boundary Stone. From Hinke, p. 102, Fig. 36.

Fig. 7. Goatfish on Round Zodiac of Dendera. From Hinke, p. 102, Fig. 37.

Fig. 8. Water-pouring God. From Hinke, p. 103, Fig. 38.

3. Tropical or sidereal zodiac?

A division of the zodiac is called *tropical*, if the dividing points are defined by their relation to the equinoxial and solsticial points, and *sidereal*, if they are defined by means of the fixed stars.

Most Greek astronomers (e. g. Hypsicles, Hipparchus, Geminus, Ptolemy, Theon of Alexandria) used a tropical zodiac, in which the sign Aries began, by definition, with the spring equinox.

However, Eudoxus and Aratus used a sidereal zodiac. The beginning points of the signs

Fig. 9. Waterman on Round Zodiac of Dendera. From Hinke, p. 103, Fig. 38.

were defined, for practical purposes, by simultaneously rising stars. The 12 signs were so chosen that their middle points coincided, as well as possible, with the middles of the 12 zodiacal constellations (Böker, p. 43). On Eudoxus' zodiac, Spica lies between 27° and 28° Virgo, whereas on the Babylonian zodiac Spica was assumed to lie between 28° and 29° Virgo. The difference is not significant.

In their *Phainomena*, Eudoxus and Aratus located the spring equinox at 15° Aries. The correct location would be, for Eudoxus' own time (368 B. C.), 6° Aries. It seems that Eudoxus himself noted and corrected this error, for Columella tells us (*De re rustica* XI, Ch. 14) that Meton and Eudoxus placed the equinox at 8° Aries. This was also the Babylonian location in the system of Kidenas, as we have seen.

The 8 degrees of Meton, Eudoxus and Kidenas remained popular for a long time. They reappear in Plinius (*Nat. Hist.* 18, ch. 59), Columella, Achilles Tatius (*Isag.* 23) and Censorinus (*De die natali* 25). The astrologer Vettius Valens (ed Kroll, p. 354) professes to have used tables of Apollonius for the sun and moon „with the addition of the 8 degrees". This can only mean that Apollonius' tables were computed for the tropical zodiac and that Vettius added 8° to bring the equinox to 8° Aries.

The original purpose of the addition of the 8 degrees must have been to reduce the tropical longitudes to the sidereal zodiac of Eudoxus and Kidenas. However, after Hipparchus discovered precession, it became clear that this aim could not be reached by the addition of a fixed number of degrees. Therefore a new rule was devised by those who wanted to stick to the sidereal zodiac. Theon of Alexandria discusses this rule in his Commentary to the Handy Tables in the following words:

> The ancient astrologers believed that the tropical points moved towards the east for a certain time and then returned to their starting point.... We shall explain the method which these astrologers follow in their computations. They take the 128 years up to the beginning of the reign of Augustus, because at the beginning of this time the deviation towards the following signs reached its largest amount of 8 degrees and the retrograde motion started, and they add the 313 years from Augustus to Diocletianus and the years elapsed since Diocletianus, and from the sum they calculate the place at a rate of motion of one degree in 80 years. They subtract the result of the division from 8 degrees. The rest, giving the degree up to which the tropical points have moved, is added to the result of the calculation of the longitudes of the sun, the moon and the 5 planets (Halma, *Commentaire de Théon sur les tables manuelles de Ptolémée*, Paris 1822, p. 53).

The „ancient astrologers", who applied this rule, lived after 29 B. C., because they used the era of Augustus. Their successors, living in the era of Diocletianus, still used the same rule, adapted to the new era. Obviously, the purpose of the rule was, to reduce tropical longitudes (taken e. g. from tables of Apollonius, Hipparchus or Ptolemy) to sidereal longitudes.

Theon's account clearly proves the popularity of the sidereal zodiac among astrologers of the late Roman period.

CHAPTER III.

THE EGYPTIAN ZODIAC.

1. Egyptian Astronomy.

Did there ever exist a genuine Egyptian astronomy, comparable to Babylonian and Greek science? Nobody knows. Late Greek authors often praise Egyptian Wisdom, but every time we learn to know texts, they lead to disappointment. The "Egyptian System" of late Roman authors is really a Greek planetary theory. The "eternal tables", in which the Egyptians are said to have laid down their wisdom about planetary motion, prove to be a mere compilation from Babylonian almanacs, ready for astrological use[36]. New Moon tables, published by Neugebauer and Volten[37], are computed by the simplest possible arithmetical devices, far inferior to Babylonian Lunar tables.

[36]) B. L. v. d. Waerden, *Egyptian "Eternal Tables"*, *Proc. Kon. Akad. Amsterdam* 50 (1947), p. 537.

[37]) O. Neugebauer and A. Volten, *Quellen u. Studien Gesch. Math.* B 4 (1938), p. 383.

The only thing that remains really and genuinely Egyptian, is the doctrine of the 36 "Decans" or Calendar Stars, which were supposed to rise and set at intervals of 10 days throughout the year, and to culminate at intervals of 1 hour throughout the night. Lists of decans are found on coffin lids of the Middle Kingdom and in royal tombs of the New Kingdom. The doctrine of their rising, culmination and setting is systematically exposed in a commentary published by Neugebauer and Lange[38]. The doctrine is rather primitive and even inconsistent, for if the 36 decans do really rise at intervals of 10 days, the mean time intervals between their culminations should be 40 minutes instead of 1 hour.

Still, these lists were the best thing the Egyptian wise men were able to give their dead as a guide through time and eternity. Obviously the Egyptians had no better method of determining time during the night than the observation of the rising, culmination and setting of decans. This means: they knew nothing about the Zodiac.

This conclusion is confirmed by the total absence of texts concerning the zodiac or related topics, before Hellenistic times. Serious Greek authors (Geminus, Hypsicles, Ptolemy) often use Babylonian methods and observations, but never Egyptian ones. If we are to rely on documents and not on fictions, we are bound to conclude: A scientific Egyptian astronomy never existed, and even if it existed it did not appreciably influence our science.

2. The Zodiac of Dendera.

Our conclusion that the Egyptians, before Hellenistic times, knew nothing of the Zodiac, is not contradicted by the Round Zodiac of Dendera, nor by the rectangular one in the same temple. For the Dendera Zodiac proves to be only a mixture of the Greek Zodiac with its Babylonian original[39]. Thus, the Ram is Greek, but the Scales are Babylonian. The pictures of the Archer and the Goatfish follow in all details Babylonian models, as we have seen already (figs. 4—9).

3. The zero-point of the Egyptian Zodiac.

If the longitudes of the planets in Egyptian planetary texts are compared with modern longitudes, the mean differences are positive and decrease in the course of time[40]. However, if the modern longitudes are reduced to the vernal point of -100, the differences remain constant. The mean differences are, if Mercury is left out of account:

4.6 for the Berlin papyrus (years -16 to $+10$),
5.1 for the Stobart tablets (years 70 to 131).

The differences were computed by Neugebauer for the "linear parts" of the motion, where the differences between text and calculation are nearly constant. Obvious text errors were disregarded, and so were the retrograde parts because of the special kind of deviations here. Mercury is quite out of line, the differences being 0.1 and -1.0 in the two texts. One reason for this may be that the linear part of Mercury's motion is very difficult to observe. This is why Mercury was disregarded in forming the mean differences.

Both values 4.6 and 5.1 lie within the range of values found from similar Babylonian tables. So the authors of these late Egyptian tables used the Babylonian sidereal zodiac, in which Spica lies between 28° and 30° Virgo.

From a horoscope of Pitenius for A. D. 81, C. Fagan[41] computed a mean difference of 6.5 with modern longitudes reduced to -100. As Fagan points out, this horoscope may well have been computed from the planetary tables mentioned before. It is also possible that the astrologer who computed this geniture used Theon's reduction rule (see end of Chapter II). In any case the zero point of this horoscope was not the vernal point of A. D. 81.

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[38]) H. O. Lange and O. Neugebauer, *Papyrus Carlsberg 1, Kong. Danske Videnskabernes Selskab* (hist.-fil. Skr.) I, 2 (1940).

[39]) This has been pointed out by A. Schott, *Quellen und Studien Gesch. Math.* B 4, p. 176.

[40]) O. Neugebauer, *Egyptian planetary texts, Trans. Amer. Philos. Soc.* 32 (1942), p. 230. See also my "*Eternal Tables*" quoted before.

[41]) C. Fagan, *Zodiacs Old and New* (London 1951), p. 28.

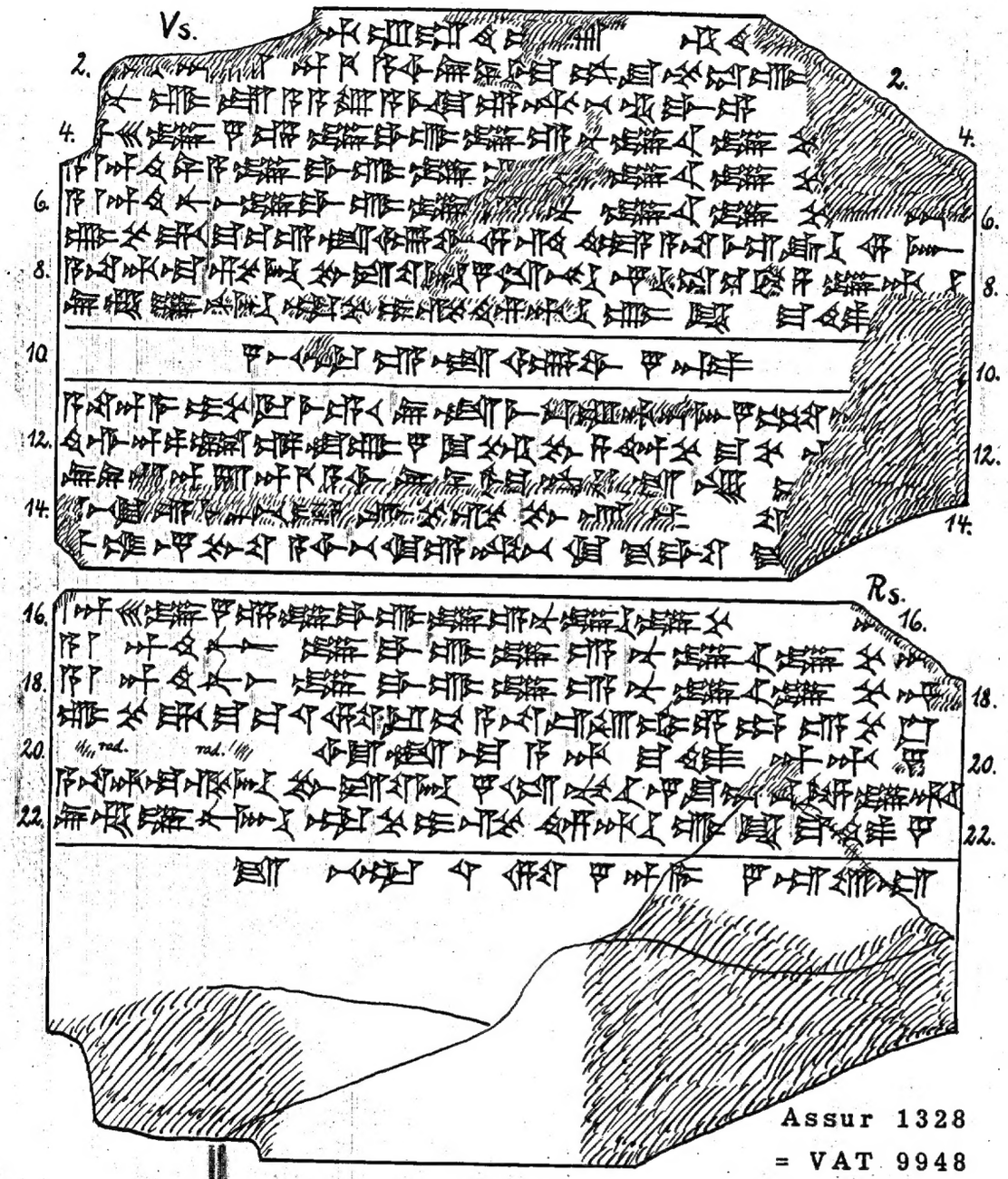
4. Hellenistic Decans.

All around the Round Zodiac of Dendera, the 36 Decans are represented. They reappear in astrological literature (see W. Gundel, *Dekane und Dekansternbilder*). Their Greek names seem to derive from the old Egyptian names. However, their character has fundamentally changed. They are no more stars, but Divine Powers associated with parts of the zodiac of 10 degrees each. To each Decan, the astrologers give a list of simultaneously rising stars. This means: the Egyptian method of determining time by rising decans, and the Greek or rather Babylonian method of determining time by rising parts of the zodiac and their paranatellonta, were combined into one scheme, by dividing each zodiacal sign into 3 equal parts and giving each part the name of an old Egyptian decan.

In my paper on the thirty-six stars [42], I have shown how the hellenistic decans are connected with the 36 stars of the Babylonian Astrolabe, with the 36 stars of ^{mul}APIN and with the 36 Chaldaean star-gods mentioned by Diodorus. Moreover, Julianus Apostata records a doctrine taught in the mysteries (of Mithra), in which the division of the zodiac into 36 "powers of gods" is brought into connection with the old-Babylonian division of the sky into the paths of Enlil, Anu and Ea [42].

Thus we see, that the doctrine of the decans, just like the rest of Hellenistic astrology, is a mixture, in which Babylonian elements prevail.

[42]) B. L. v. d. Waerden, *Babylonian Astronomy* II, *J. Near Eastern Studies* 8 (1949), p. 6.



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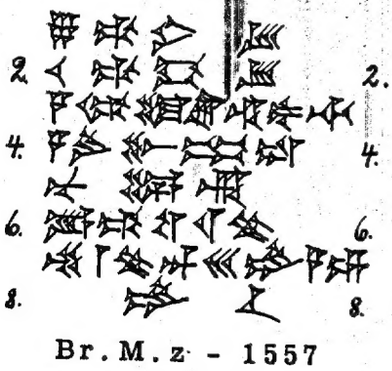

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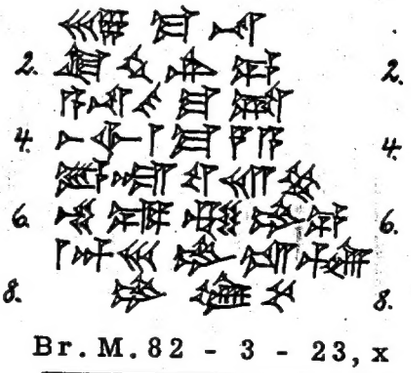

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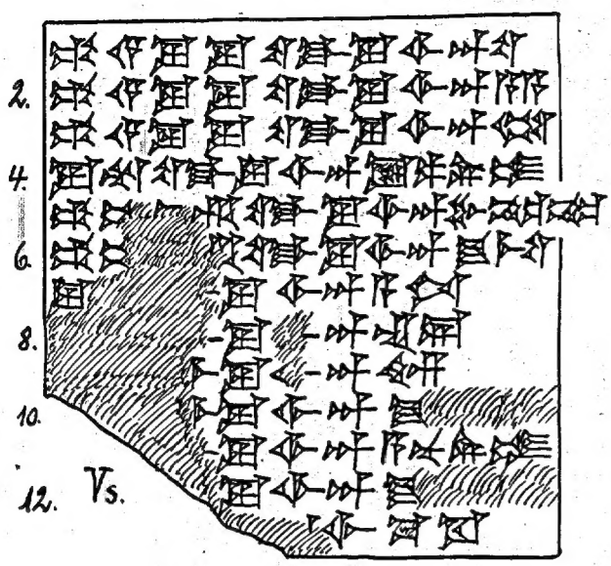

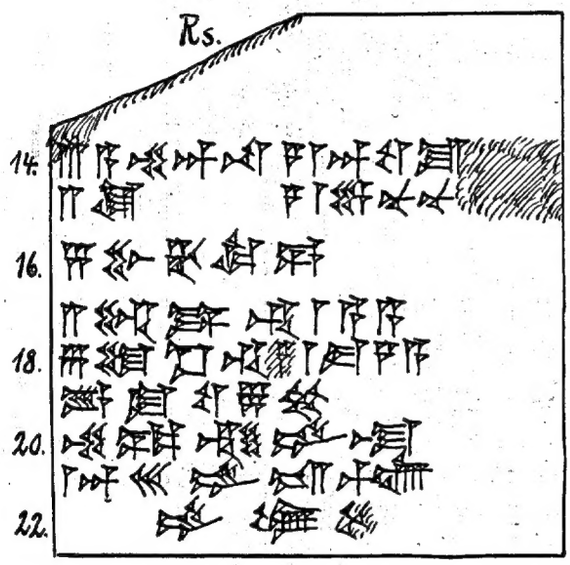

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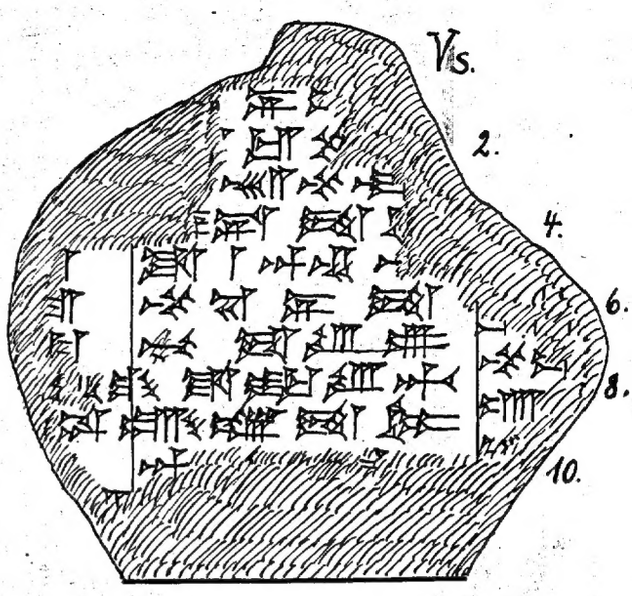

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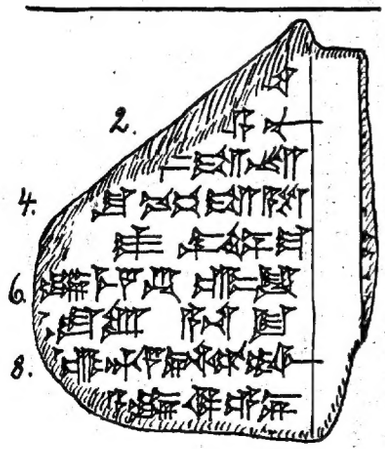

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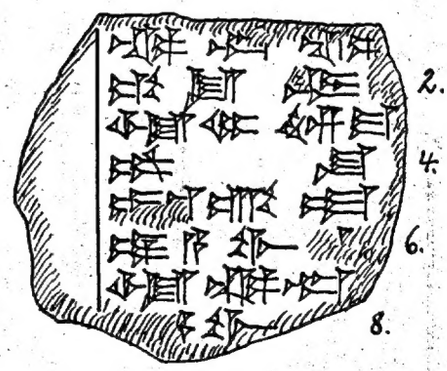

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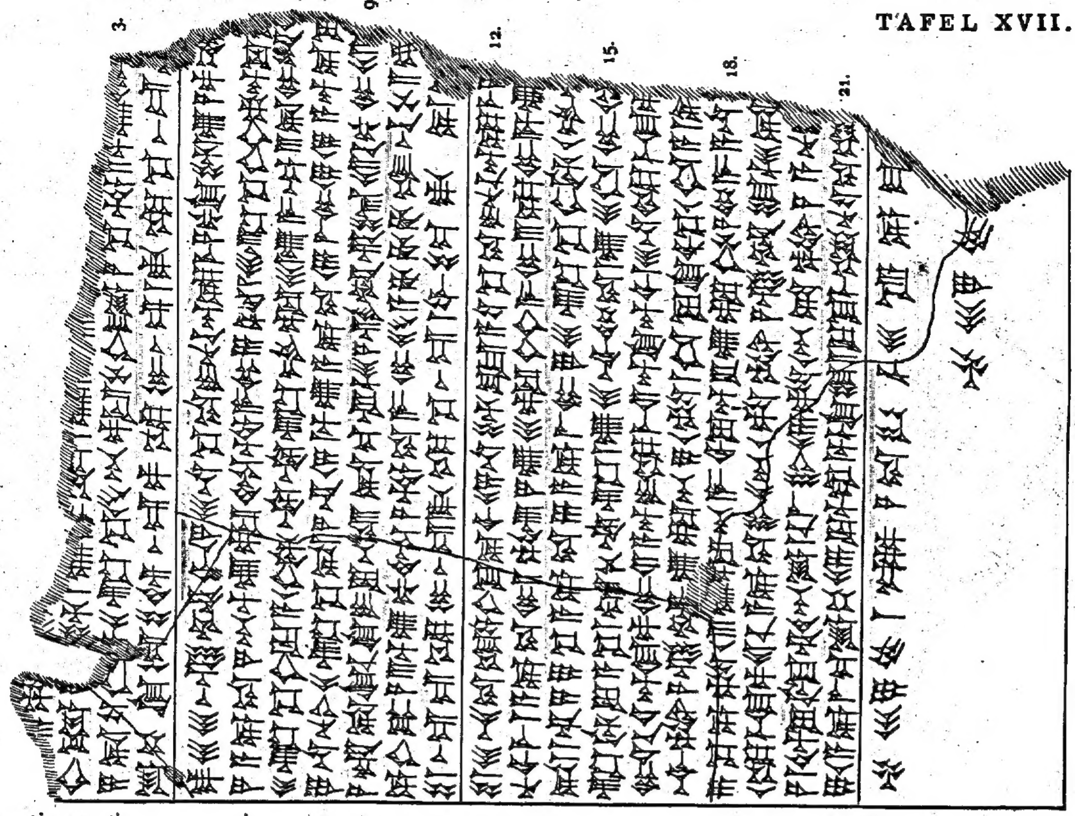

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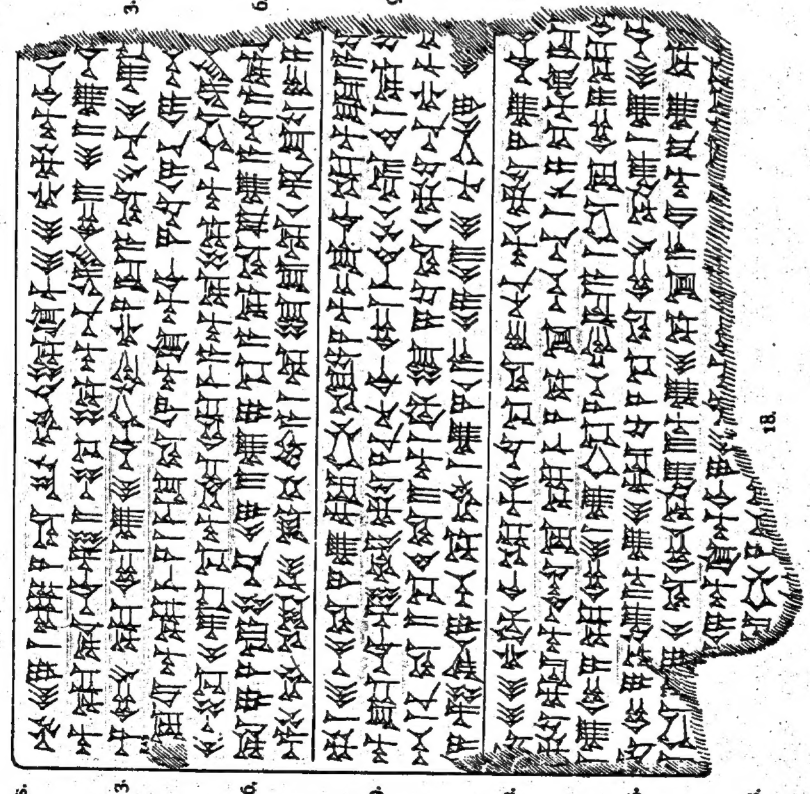

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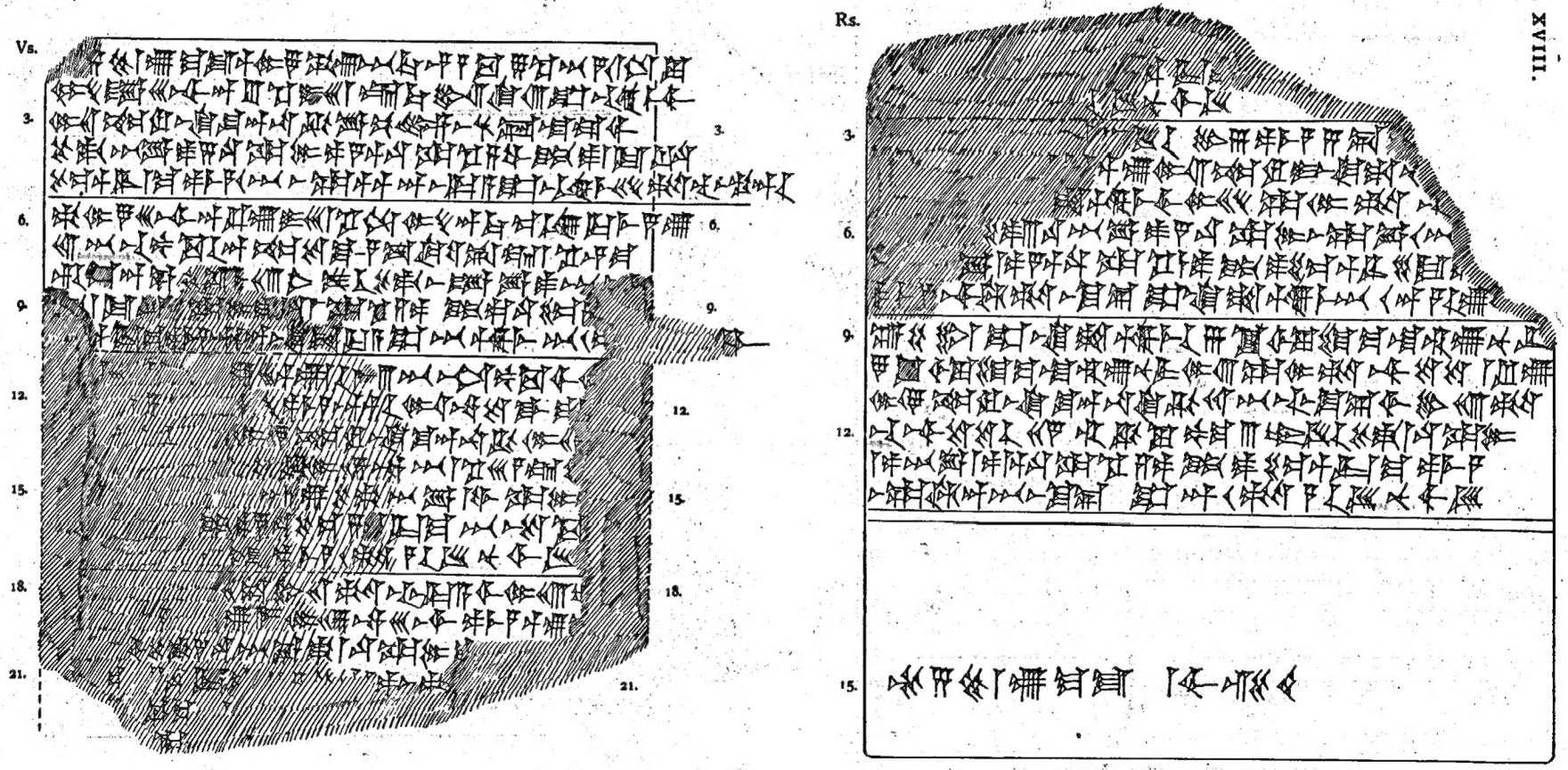

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